

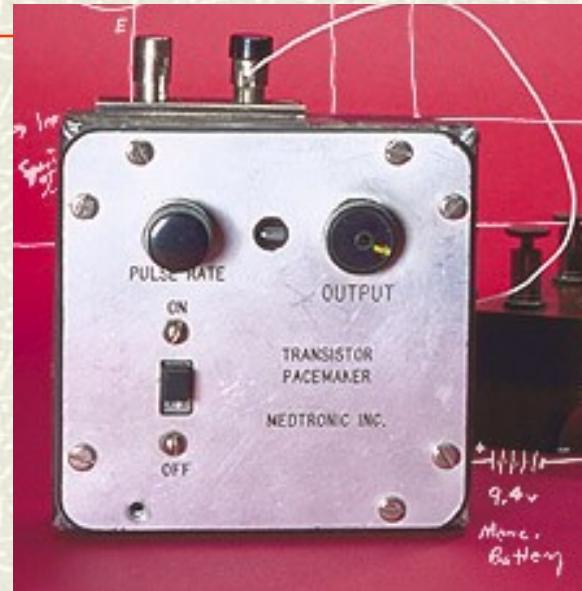
Pacemakers & ICDs

Christian Popa, MD



1st pacemaker 1957

**Earl Elmer Bakken, Founded Medtronic,
#111 on Forbes 500 in 2003**



"Back at the garage, I dug out a back issue of Popular Electronics magazine in which I recalled seeing a circuit for an electronic, transistorized metronome. The circuit transmitted clicks through a loudspeaker; the rate of the clicks could be adjusted to fit the music. I simply modified that circuit and placed it, without the loudspeaker, in a four-inch-square, inch-and-



Pop Quiz

Most modern internal pacemakers use (epicardial or endocardial) leads

How many letters in the **pacemaker coding system** and what do they mean ?

T or F- You should place a temporary transvenous pacemaker in a patient with LBBB while placing a PA catheter.

T or F- An asymptomatic patient with 3rd degree heart block and a HR of 38 should receive a permanent pacemaker.

T or F - Temporary transvenous pacing is associated with a high complication rate.

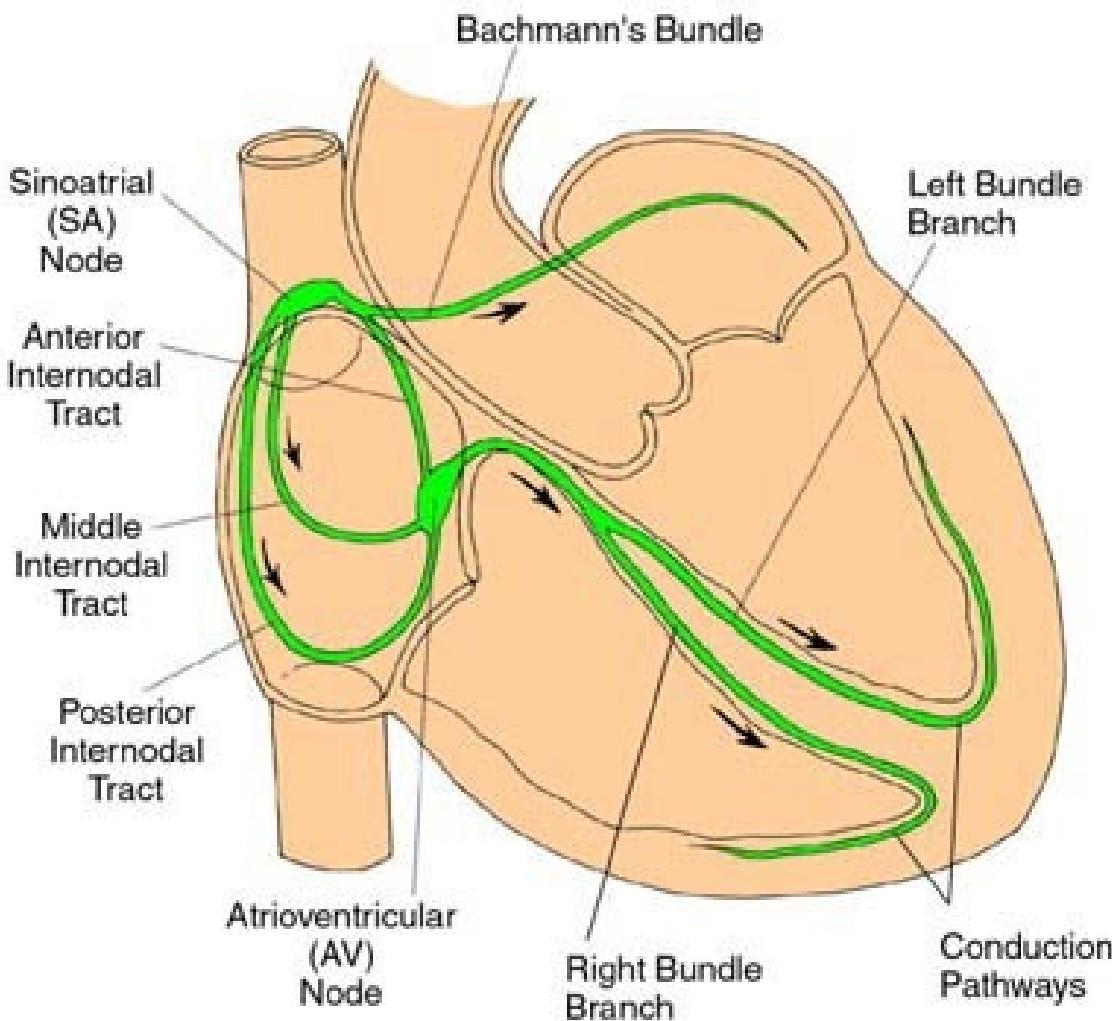
What is the **sensing threshold** ?

(a) What is the **pacing threshold** and (b) Name 3 metabolic abnormalities that affect the pacing threshold.

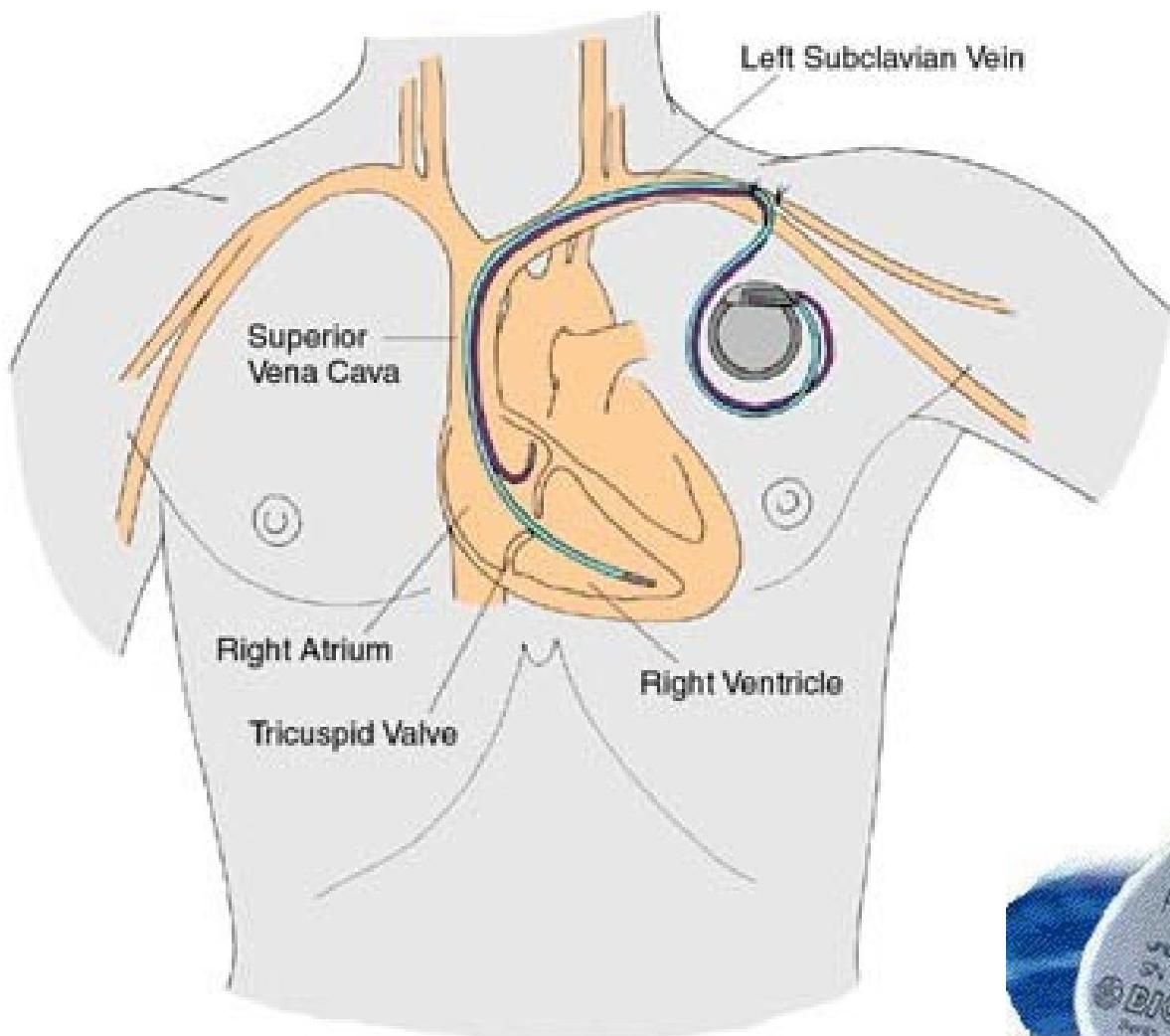
T or F- For surgery, DDD mode is preferable to DOO mode.

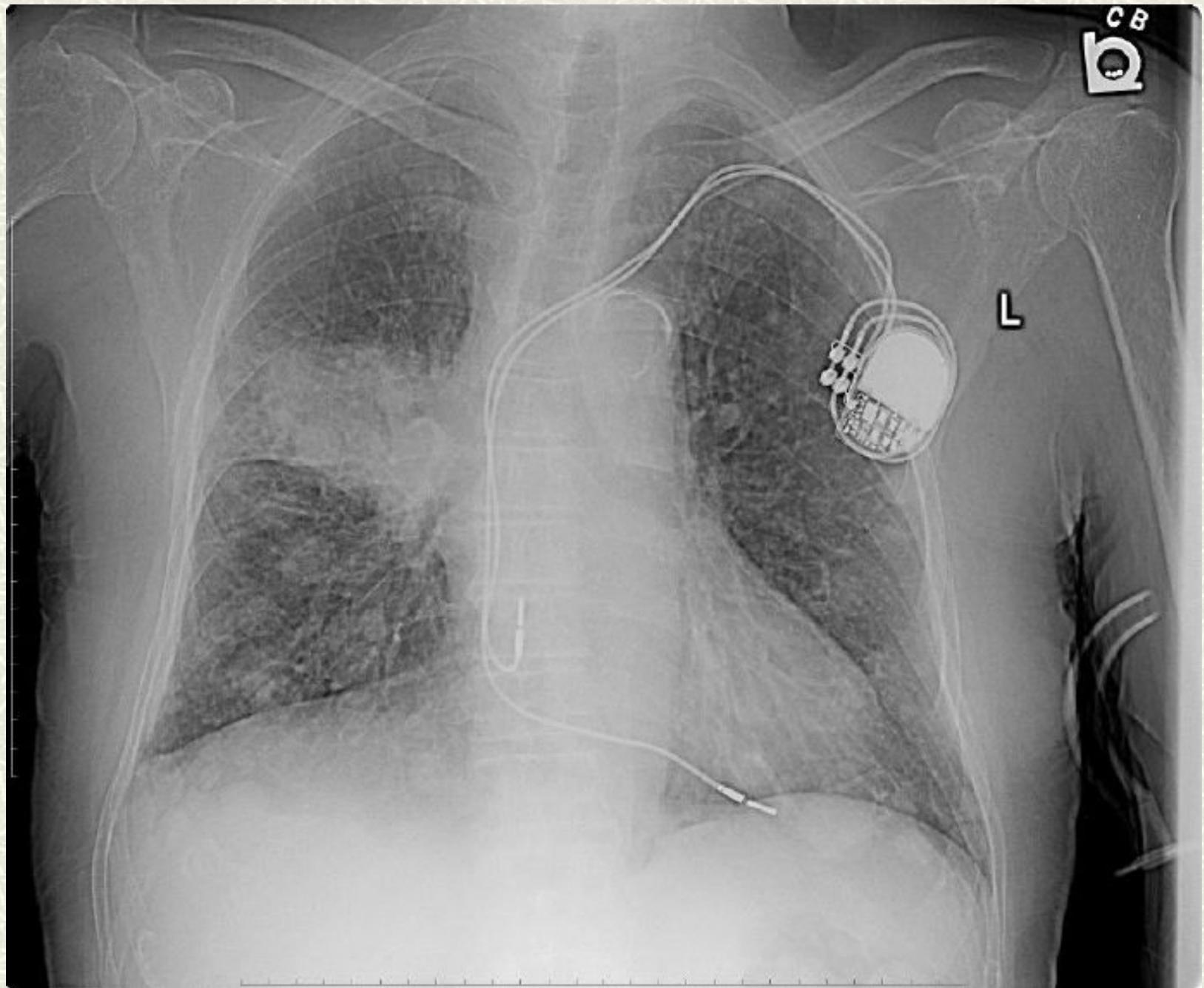


The Electrical System of the Heart



Dual-Chamber Pacemaker





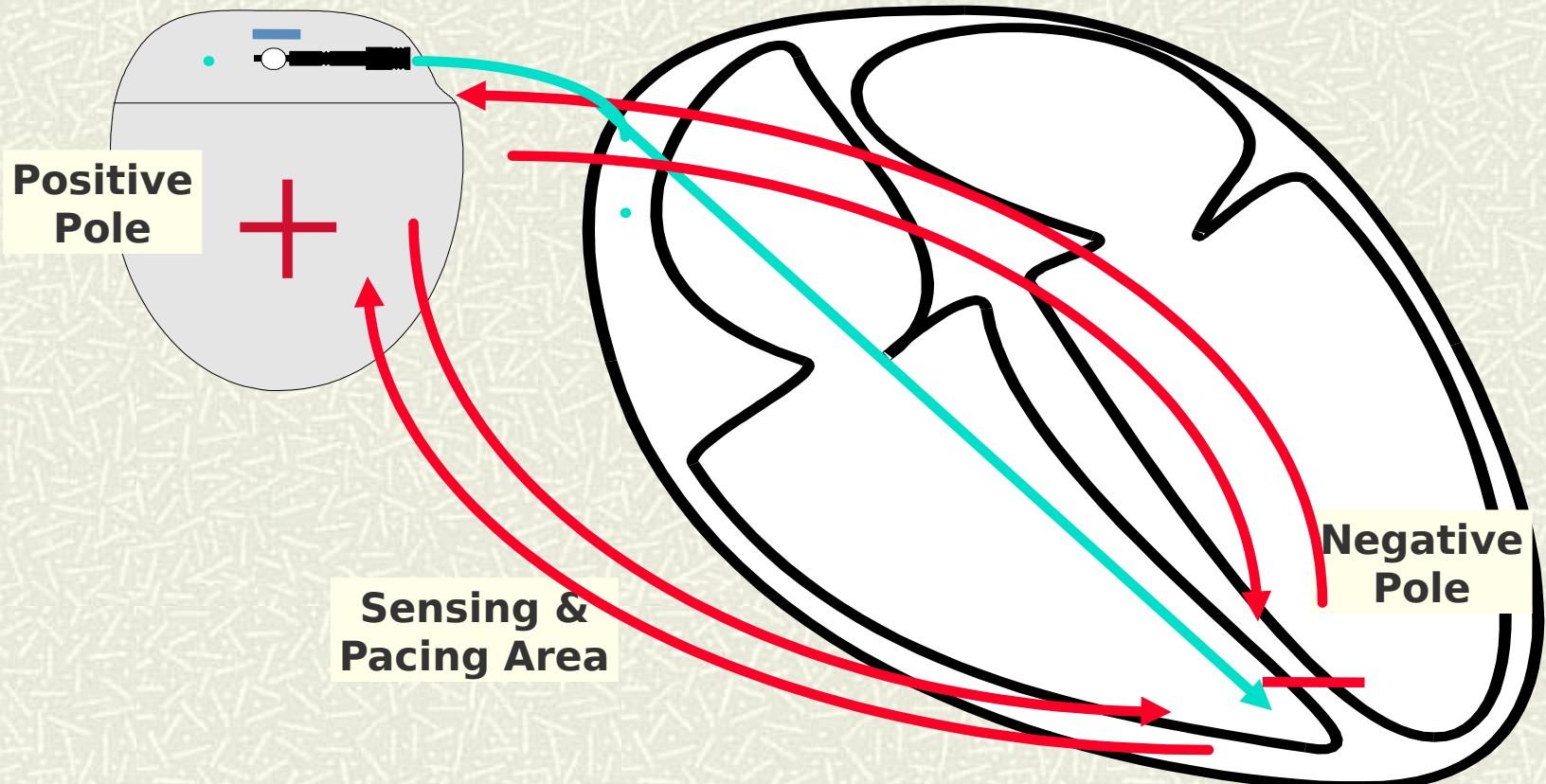
CB
b





Unipolar versus Bipolar

Unipolar





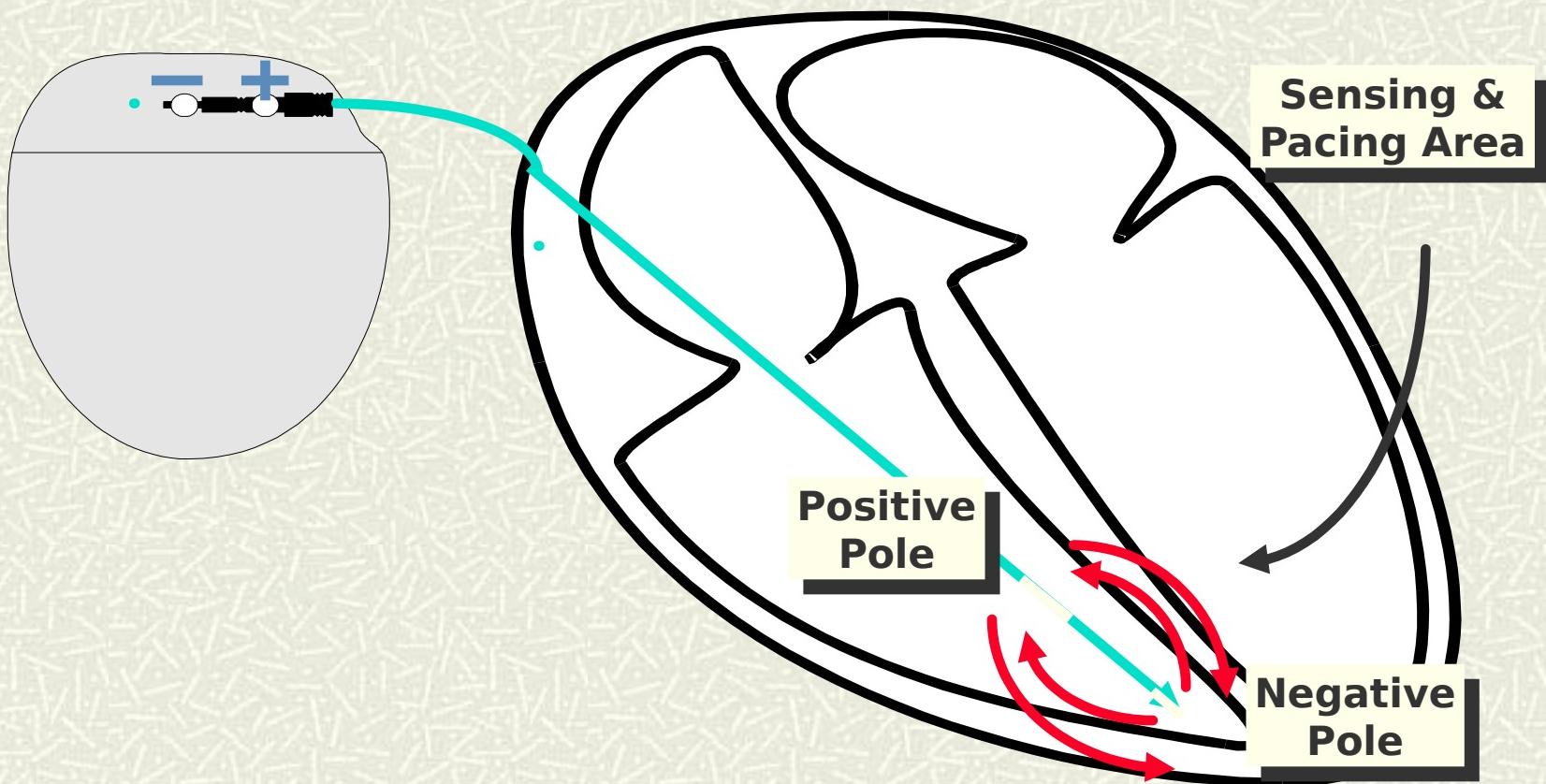
Unipolar Pacing

PROS: Unipolar sensing pacemakers *typically* have better intrinsic signal strength.

A large pacemaker artifact to aid in recognition of captured beats on monitoring equipment or the surface ECG.

CONS: Pocket stimulation.
Cannot be used with implantable defibrillators.
More susceptible to electromagnetic interference, myopotential sensing, and far-field sensing.

Bipolar





Bipolar Pacing

Pro: No pocket stimulation. Bipolar sensing is less susceptible to myopotential inhibition, electromagnetic interference, and far-field sensing.

- *If an implantable defibrillator and pacemaker are used in the same patient, the pacemaker should be programmed to the bipolar pacing configuration so double counting does not occur. The pacemaker must retain its bipolar polarity in its “back-up” mode.*

Con: Small pacemaker artifact on the surface ECG or monitoring equipment- *Unless the ECG equipment has digital enhancement*



Settings

Vent Rate (30-180)

Atrial Output 0 to 20 mA

Ventricular Output 0 to 20 mA

AV Interval 0 to 300 msec

Atrial and ventricular
sensitivity (1 to 10 mV)



The NASPE-BPEG pacemaker code

I Chamber Paced Antitachycardia	II Chamber Sensed	III Response to Sensed Event	IV Programmability	V Rate Response
Functions				
O (none) (none)	O (none)	O (none)	O (none)	O
A (atrium) (adaptive rate)	P (ATP)	A (atrium)	I (inhibit)	R
V (ventricle) (simple programmable)	S (shock)	V (ventricle)	T (triggered)	P
D (dual; A + V) (dual; P + S)	D (dual; A + V)	D (I + T)	M (multiprogrammable)	D
S (single)	S (single)		C	



Capture

The depolarization and resultant contraction of the Atria or Ventricles in response to an electrical stimulus emitted by a pacemaker.

One-to-one capture occurs when each electrical stimulus causes a corresponding depolarization and resultant cardiac contraction.



Sensing

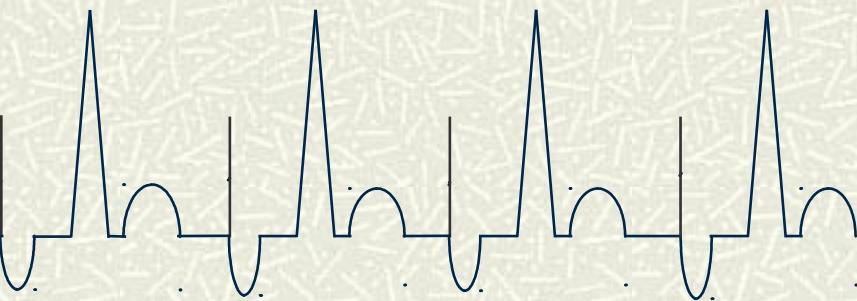
- ❖ Definition: The ability of the pacemaker to sense an intrinsic electrical signal. Sensing is dependent upon the amplitude, slew rate, and frequency of the signal.
- ❖ The sensitivity setting of the pacemaker indicates the minimum intracardiac signal required by the pacemaker to initiate the pacemaker response (inhibited or triggered).



Threshold

- ❖ Stimulation Threshold - The minimum amount of electrical energy that consistently produces a depolarization and resultant contraction.
 - can be expressed in terms of amplitude (milliamperes or volts), pulse duration (milliseconds), charge (microcoulombs), or energy (microjoules).

Atrial Capture



Ventricular Capture



Atrial + Ventricular Capture

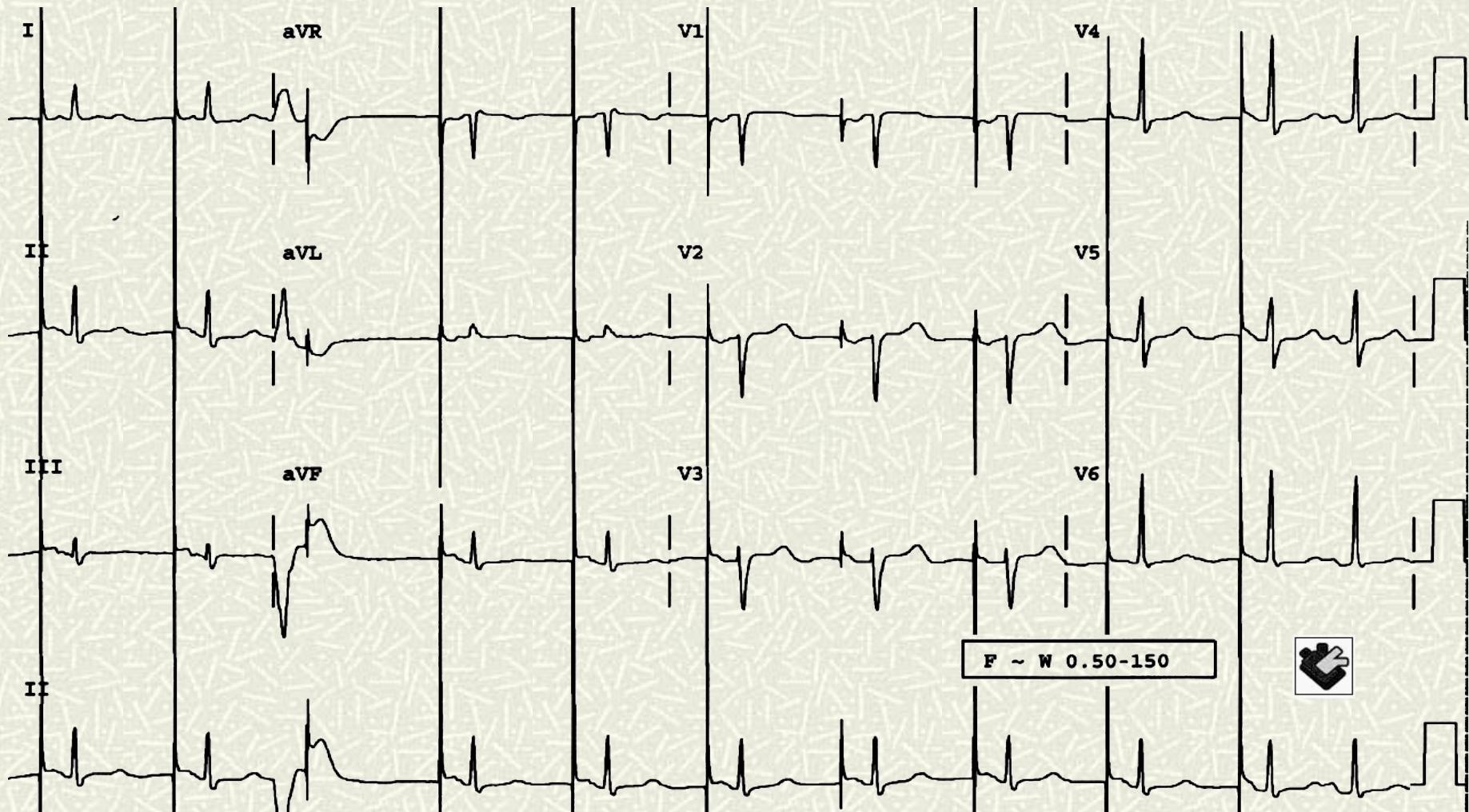




ECG Analysis

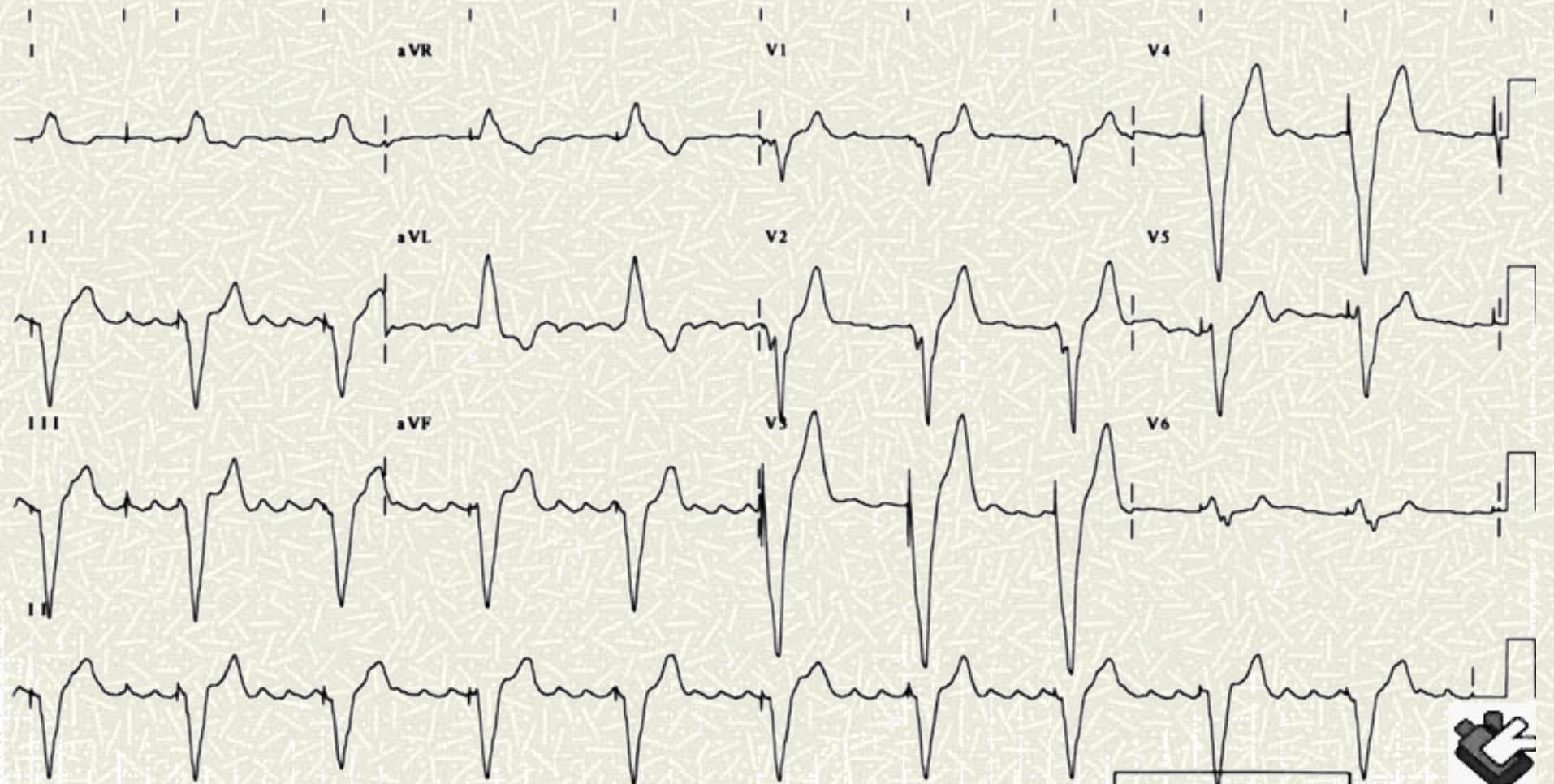


What type of pacer ?



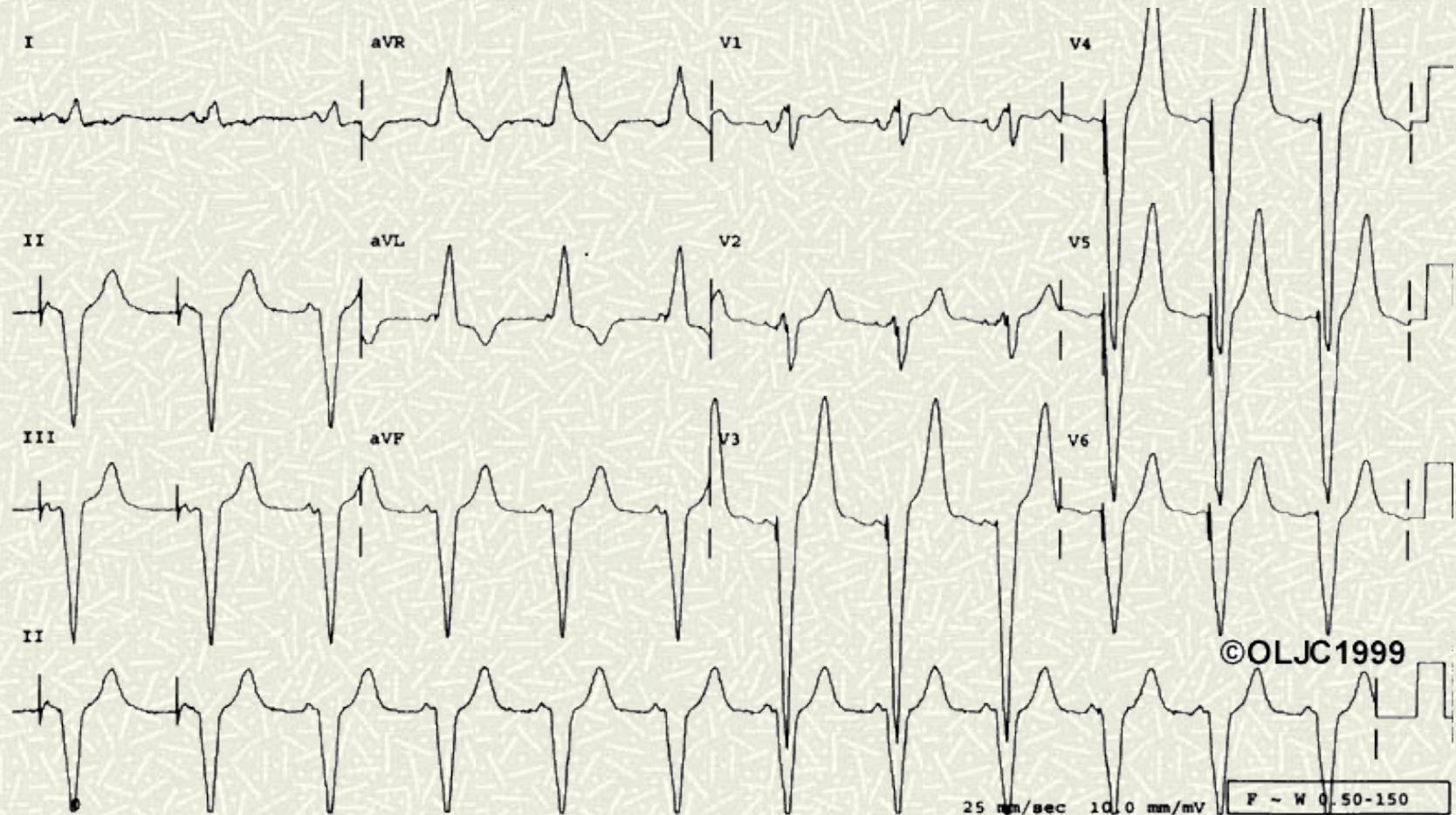


What type of pacer ?



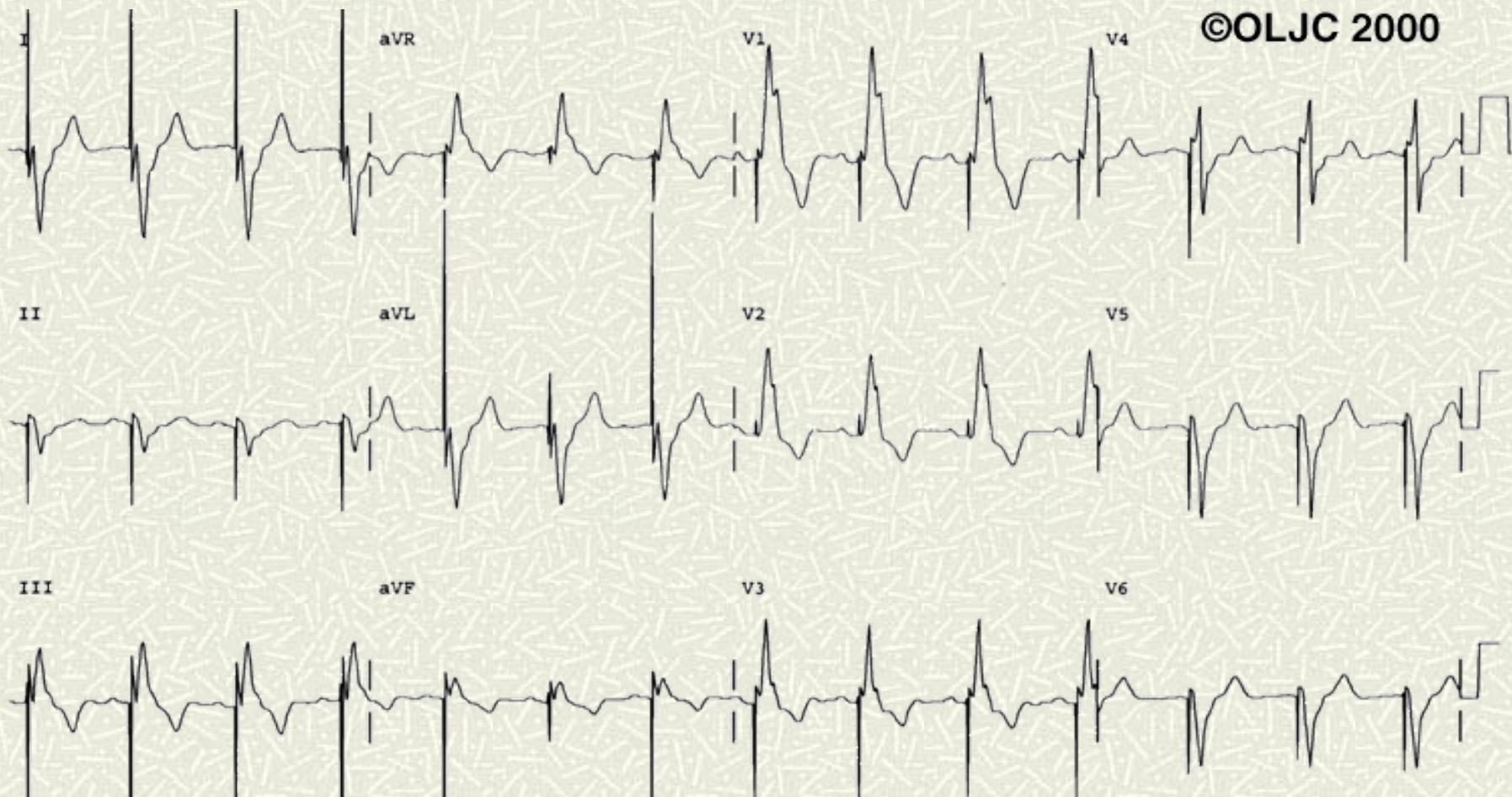


What type of pacer ?





What's wrong with this picture ?





Class I Pacemaker Indications

3° AVHB AND

Symptomatic bradycardia or need for drugs causing same

After catheter ablation of AV junction

Postoperative

Neuromuscular disease

Escape rhythm < 40 bpm or asystole > 3 s in
ASYMPTOMATIC patient

Permanent / intermittent symptomatic type II 2° AVHB

Recurrent syncope caused by carotid sinus
hyperstimulation

During AMI- asystole, new RBBB or bifascicular block with 1°
AVHB, alternating BBB, or type II AVHB



Class II Pacemaker Indications

Asymptomatic 3 ° AVHB with rate > 40 bpm

Asymptomatic Type II 2 ° AVHB

Type I 2 ° AVHB below His bundle without symptoms

1 ° AVHB with symptoms of low cardiac output or CHF

BFB or TFB block with syncope not proven due to AVHB but with no other identifiable cause

SND with heart rates < 40

During PA catheter insertion in patients with LBBB

New RBBB or new BFB with AMI (no 1 ° AVHB)



Class III Pacemaker Indications

Asymptomatic 1° AVHB

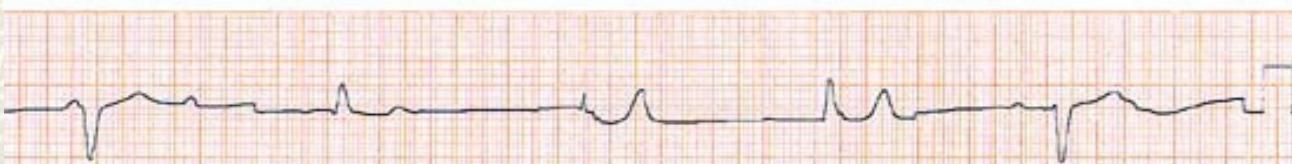
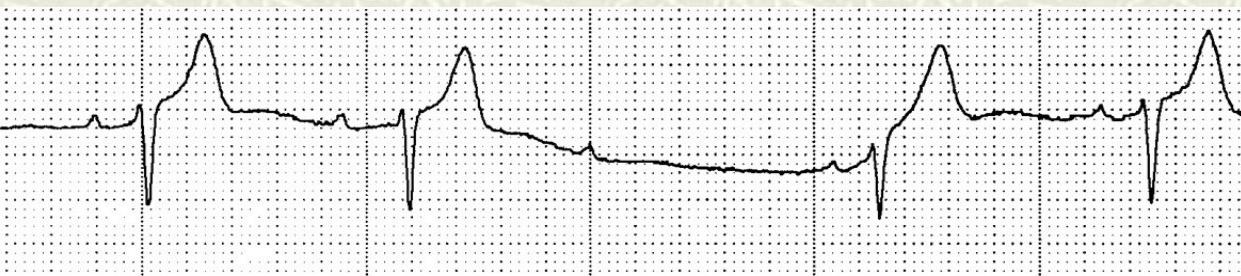
Asymptomatic Type I, 2° AVHB

AVHB that is expected to resolve

BFB or TFB without AVHB or symptoms

BFB or TFB with 1° AVHB without symptoms

Recurrent syncope in absence of hypersensitive carotid sinus response



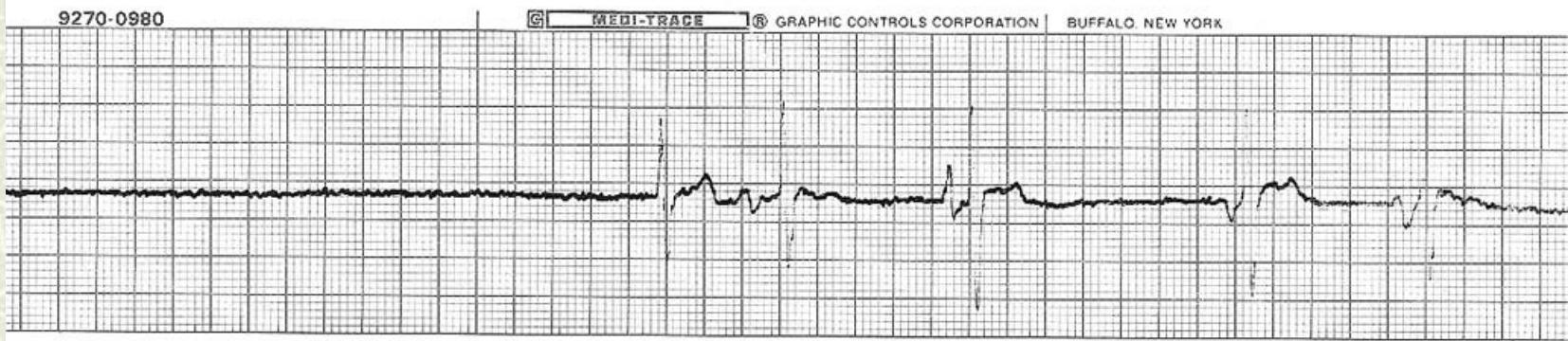
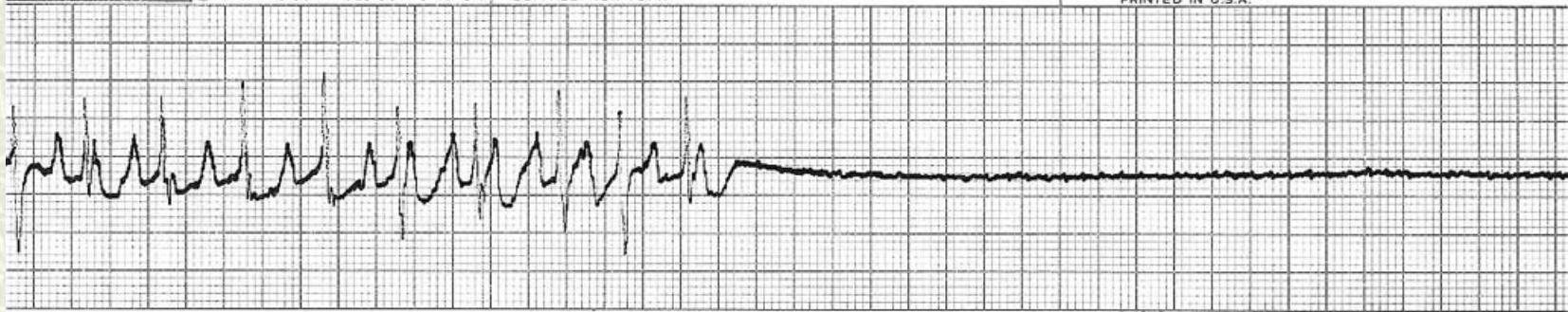


What is this ?

007 01 FEB 70 8432 ICL 43 ULHRSUJ JOHN PHYSYSTULE HR 8

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PRINTED IN U.S.A.





Pacemaker Malfunction

❖ Failure to pace

Intrinsic cardiac depolarization

Oversensing

Broken, dislodged, disconnected leads

Impending battery depletion

❖ Failure to Capture

Fibrosis at lead-tissue interface

Drugs or conditions which ↑ pacing threshold

❖ Pacing at abnormal rates

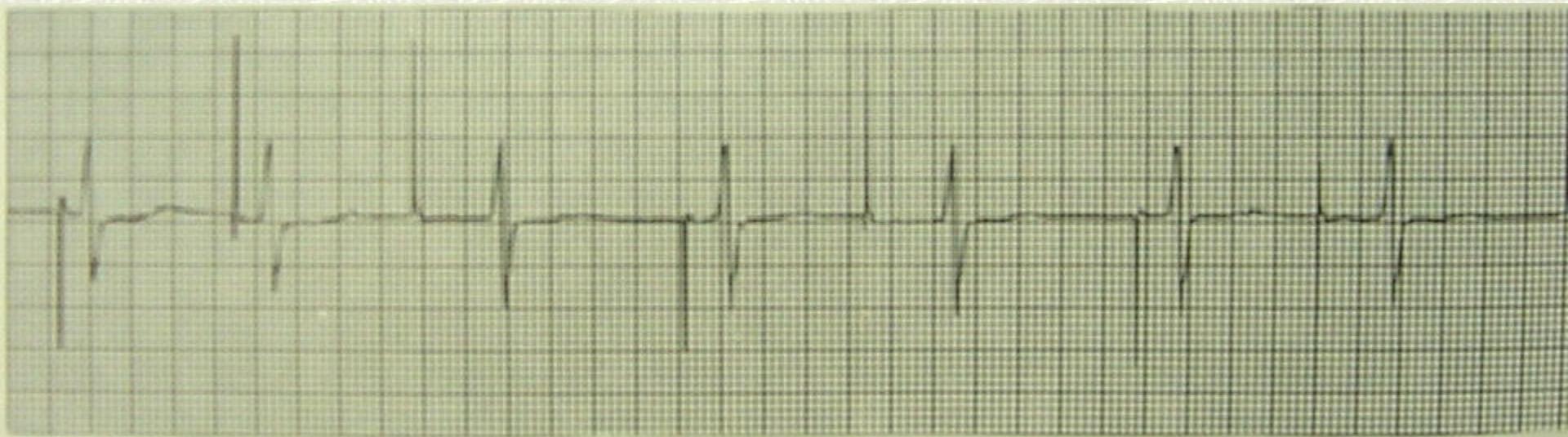
Oversensing

adaptive rate pacing

Crosstalk Inhibition with dual-chamber devices



What does this depict ?



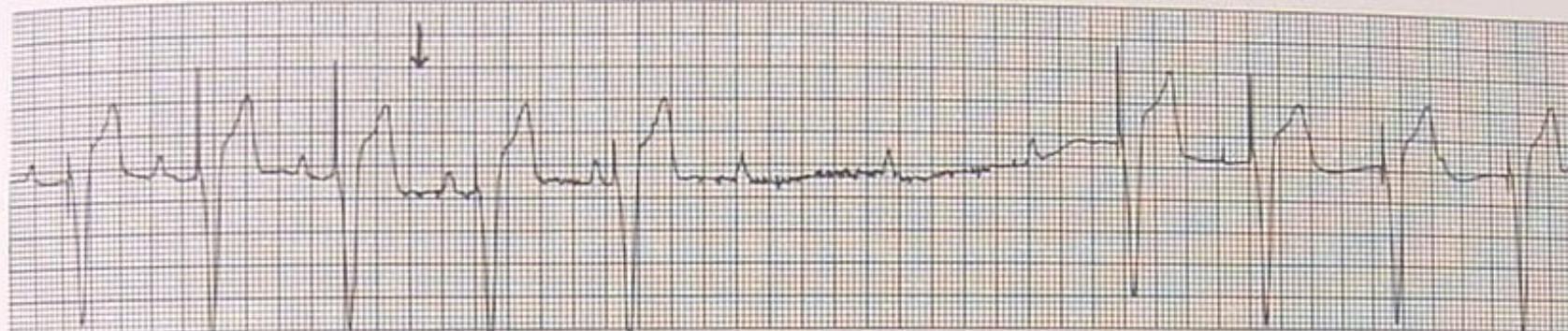


FIGURE 32-4 Myopotential inhibition of a unipolar permanent pacemaker. The pulse generator was placed next to the pectoral muscle, and inappropriate inhibition of the pacemaker

occurred whenever the patient adducted her arm. Forceful arm adduction begins at the arrow where muscular artifact can be discerned in the tracing.

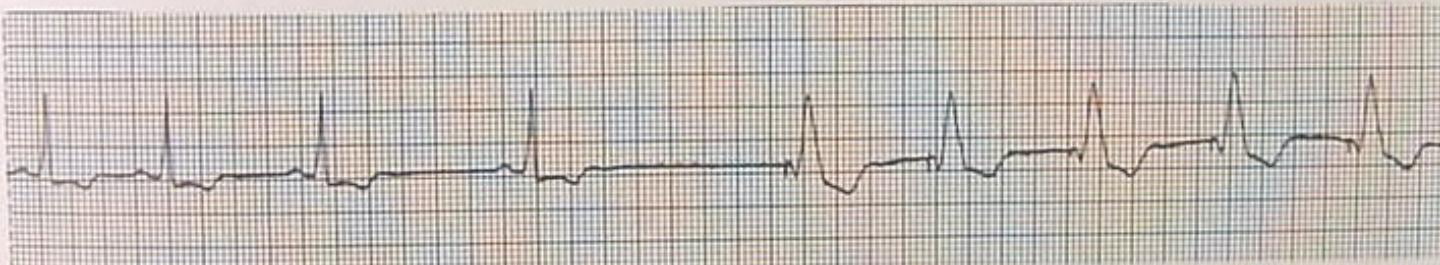


FIGURE 32-5 Pacemaker hysteresis. The pacemaker is programmed to pace at 70 pulses per min, but not to start pacing until the heart rate has fallen below 40 bpm.



Response of Pacemaker to Magnet

Most devices- Asynchronous pacing in SOO or DOO mode at programmed rate (Thera DR or D, Medtronic, 85 bpm)

With battery depletion, pacing at EOL indicator (Thera DR or D, Medtronic, 65 bpm)

Useful for malsensing, EMI

However- magnet response may have been programmed off, device may continue to pace asynchronously, or pacing will cease after a preprogrammed interval. Worst, EMI will open a programming circuit.

MOST ICDs- magnet will turn off sensing/shock delivery while magnet is in place.

Potential Sources of EMI

EMI Source	Asynch	Generator Rate	Complete		One-beat
	Damage		Inhibition	Inhibition	
	Pacing	Increase			
Electrocautery	Yes	Yes	Yes	Yes	Yes
External DCDF	Yes	No	No	Yes	Yes
MRI scanner	Possible Yes		No	Yes	Yes
Lithotripsy		Yes	Yes	Yes	Yes
RF Ablation	Yes	Yes	No	No	Yes
ECT	No	Yes	Yes	Yes	Yes
TENS	No	Yes	No	Yes	Yes
Radiation Therapy	Yes		No	No	No
ECT generally safe	Yes				
Digital Diagnostic Radiation	No	Synchronized to EKG, Δ DDD to DSOO			No
ECG	Yes				



For Elective Surgery

Consult ICD Service/Clinic for Device Interrogation and Programming

Program to Asynchronous mode

Magnet activated testing/programming turned OFF

Adaptive rate pacing OFF

Tachycardia sensing for ICD OFF

Device needs to be tested/reprogrammed after surgery

Do not place cautery grounding pad so that pacer & leads are located between bovie and grounding pad

Lowest possible energy and short bursts on cautery

Monitor arterial pulse form and heart sounds to detect hemodynamic instability

Have external defibrillator- if needed locate pads ≥ 10 cm from pulse generator. Use ant-post placement. Current flow should be



For Emergent Surgery

Identify device

Contact Manufacturer, follow recommendations

Check EKG- if no pacing artifacts, place magnet over pulse generator to see if device functional.

Reprogram the device to asynchronous mode if possible. If not use magnet in the OR to do this if needed.

DO NOT place magnet on a AICD unless shocks or antitachycardia pacing in response to EMI is destabilizing

Device still needs to be checked, reprogrammed post- procedure.



What affects pacing threshold ?

↑ Pacing threshold

Bretyllium, sotalol, possibly lidocaine, B blockers, procainamide, quinidine, verapamil

Hyperkalemia, acidosis/alkalosis, hypoxemia, cardioversion/defibrillation

↓ Pacing threshold

Atropine, catecholamines, glucocorticoids, myxedema, hyperglycemia

No proven effect- amiodarone, anesthetics



Medtronic, Inc.
Implanted Device Identification



I have a Jewel Plus defibrillator implanted.

If emergency, call 911. Perform CPR. Device's Therapeutic shocks may be felt but will not be harmful. EMT: Place the EMT Defibrillator paddles 15 cm away from ICD. If ineffective, switch positions to posterior-anterior. Placing a magnet over the ICD will prevent delivery of therapy but will not alter Brady pacing.

Please contact my doctor(s):

Margaret Smith, M.D.
(612) 754-0549

Jane Johnson, M.D.
(612) 871-2345

My device may trigger metal detection systems.



Medtronic, Inc.
Implanted Device Identification



I have a Thera I DR pacemaker implanted.

In case of a medical question or emergency,
please contact my doctor(s):

Margaret Smith, M.D.
(612) 754-0549

Jane Johnson, M.D.
(612) 871-2345

My name:

DOE, JOHN
123 MAIN ST
HOMETOWN MN 55555

My defibrillator system model, serial numbers,
and implant dates:

72208	PCV010101H	15 NOV 1996
6936110	TAT020202Y	15 NOV 1996

Medtronic Patient Toll-Free Number: 1-800-551-5544

Medtronic Web: <http://www.medtronic.com> Order#7150

My name:

DOE, JANE
1234 MAIN ST
HOMETOWN MN 55440

My pacing system model, serial numbers,
and implant dates:

746618	PDB200123W	15 FEB 1997
553445	LDG012345Y	15 FEB 1997
503458	LDF023456Y	15 FEB 1997

Medtronic Patient Toll-Free Number: 1-800-551-5544

Medtronic Web: <http://www.medtronic.com> Order#7150

Transcutaneous Pacing

Simultaneous atrial and ventricular capture

Threshold for capture 35 – 70 mA, pulse width 40 ms (35 to 70 J)

Does not always work- obese, COPD



Esophageal Pacing

Only atrial capture is reliable

Unsuitable for advanced Hb or Afib

Advance catheter 35 to 45 cm from lips

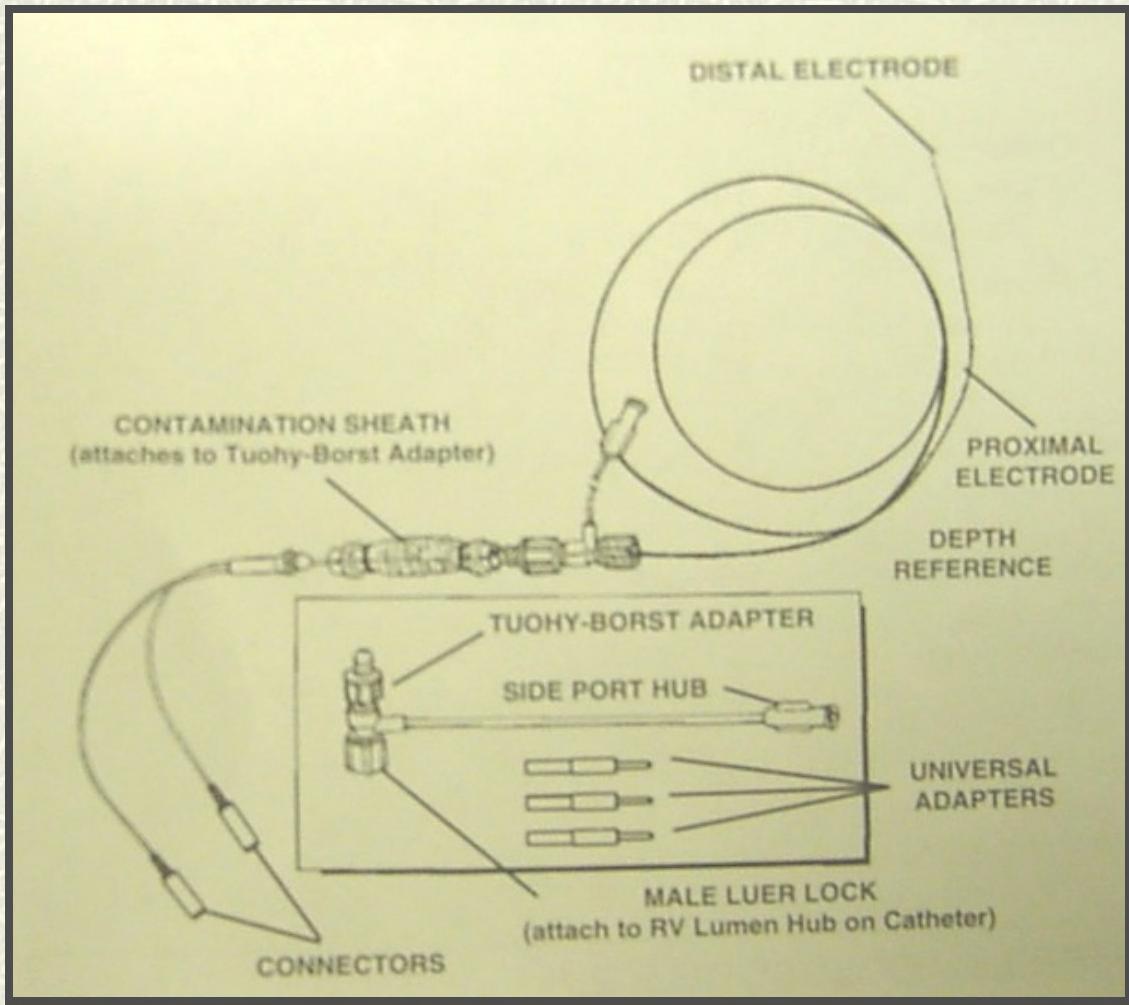
Usually capture at 15 to 25 mA with pulse width of 10 ms



Transvenous pacing

Balloon tipped catheter

Wire which can go through Paceport Swan or through VIP port of standard PA catheter

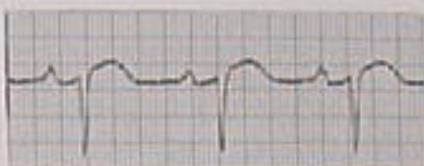




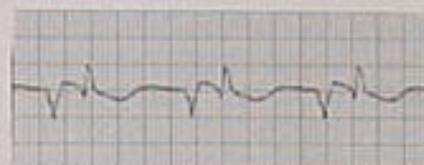
TEMPORARY TRANSLUMINAL
RV PACING LEAD



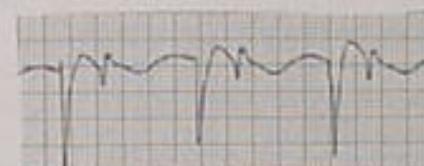
Surface Lead II



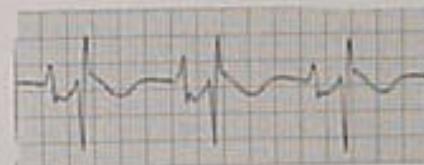
Superior Vena Cava



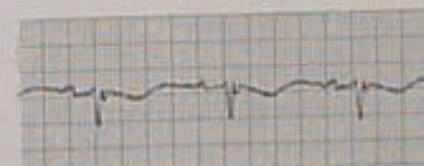
High Right Atrium



Mid Right Atrium



Low Right Atrium



Right Ventricle
(Good Contact)

